the chief argument against it being that the ambiguity of real and false effects only exists at the limit of vision, whereas most of the canals considered are, *when well seen*, far within this limit.

A number of interesting points concerning the canal systems are deduced from the 1903 observations, but only one or two of the more striking may be mentioned here. (1) The majority of the double canals do not exceed 3°·2 (degrees on the planet's surface) in width; (2) at the time of maximum visibility the two members of each double are generally of equal strength, but as they wane one of them usually becomes apparently stronger than the other; (3) the double canals appear to congregate in special longitudes and latitudes, in the latter case especially favouring the equatorial regions, a fact which Mr. Lowell urges as an argument against the "diplopic" theory; (4) the double canals are peculiar to the lighter regions of the planet's surface, although single canals are, apparently, just as numerous in the darker as in the lighter regions; the double canals, however, are always connected, directly, or through the medium of similar objects, with the darker areas.

CATALOGUE OF NEW DOUBLE STARS.—Prof. Hussey's ninth catalogue of double stars, discovered with the 12-inch and 36-inch refractors of the Lick Observatory, and mostly measured with the latter instrument, is contained in Bulletin No. 74 of that observatory. The preceding catalogues have severally appeared in Nos. 480, 485, and 494 of the *Astronomical Journal,* and Nos. 12, 21, 27, 57, and 65 of the Lick Observatory Bulletins.

The present publication gives the catalogue and D.M. numbers, the position and the distance and position-angle determined at each observation for each of the double stars recorded. The catalogue numbers extend from 801 to 1000 inclusive, and run consecutively.

## *THE ROYAL SOCIETY CONVERSAZIONE.*

MANY instruments and devices of scientific interest were shown at the Royal Society's conversazione on Wednesday, May 17. As usual, the exhibits illustrated methods and results of recent work in various branches of science, and the subjoined summary of the official catalogue contains a few particulars relating to them.

In the course of the evening lantern demonstrations were given in the meeting-room by Dr. E. A. Wilson, Sir Oliver Lodge, and Mr. Perceval Landon. Sir Oliver Lodge demonstrated the use of electric valves for the production of high-tension continuous current. Electric vacuum valves, which it is now found were suggested in a letter by Sir George Stokes twenty years ago, have as their function the *entrapping* of a portion of electricity by permitting its passage in one direction and stopping its return. They therefore can be employed to accumulate electricity supplied from an intermittent or jerky source and to store it at a steady high potential; so that it may thereafter maintain a current through a very high resistance, as in electrostatics, and may produce X-rays, or point-discharge, or other continuous high-tension effects, and enable a small portable coil to imitate some of the effects of a much larger one by storage and accumulation of impulses. Among the applications contemplated are the separation of metallic fume and the dissipation of fog.—Dr. Edward A. Wilson showed a number of Antarctic views illustrating the life and work done on board the *Discovery* during the years 1902 to 1904, and views of the seals, penguins, and other birds met with in the Antarctic circle; and Mr. Perceval Landon exhibited pictures of the road to Lhasa.

The other exhibits are here grouped together according to subjects more or less closely related to one another.

Specimens illustrating the action of light and of radium upon glass: Sir William Crookes, F.R.S. (1) It is well known that many samples of colourless glass containing manganese slowly assume a violet tint when exposed to sunlight. In some specimens of glass exhibited the pieces were of all depths of tint, from deep violet, almost black in thick pieces, to pale amethyst. Analysis shows the glass to contain manganese. Heating the glass in a covered crucible to its softening point discharges the colour, leaving the glass white and transparent. The coloration is not superficial. On immersing a piece of the coloured glass in a liquid of about the same refractive index as itself, the colour is seen to have penetrated throughout the mass. Radium, acting for a few days, even through quartz, will produce as intense a coloration in a piece of this glass as exposure to the sun on the Pampa has taken years to effect. Six pieces of glass from the greenhouses at Kew Gardens illustrated changes which took probably about fifty years to complete in our climate. Purple spots were produced on two of these specimens by Sir William Crookes by the action of 15 milligrams of radium bromide in a quartz tube in the course of ten days, the beginning of change being well marked at the end of two days. In a specimen of manganese glass exposed to light for forty years as a pane of a greenhouse, the ends of the glass which had been protected from light by the window frame were colourless. In the expectation that radium might have a reducing effect on the manganese compound, Mr. F. Soddy submitted a portion of the pane to the action of 30 milligrams of radium bromide for three days in May, 1904. The colour, however, instead of being diminished, was intensified. Specimens were also shown illustrating the coloration of glass, quartz, and fluorspar by the $\beta$ rays of radium.

Action of actinium or emanium emanation on a sensitive screen: Sir William Ramsay, K.C.B., F.R.S. Actinium or emanium are different names, adopted by Debierne and Giesel respectively, for the same substance, separable from pitchblende, and accompanying lanthanum. It gives off an emanation, of which the period of activity is very short—a few seconds. When this emanation impinges on a sensitive zinc sulphide screen, the screen becomes luminous. The luminous patch can be blown away, and in a second or two reappears.—Phosphorescence caused by the $\beta$ rays of radium: Mr. G. T. Beilby. Phosphorescence of calcspar and other substances—(1) during exposure to the rays; (2) after removal from the rays; and (3) revived by heat after secondary phosphorescence has died down. The storage of phosphorescence and the coloration effects are due to partial electrolysis of the calcium carbonate or other substance by the stream of negative electrons. A proportion of the ions re-combine at once, others continue to re-combine after the rays have ceased to act, and the remainder only re-combine when the mobility of the crystal molecules is increased by heat.—Skiagrams of the hands of Machnow, the Russian giant, and of O'Brien, the Irish giant: Mr. S. G. Shattock.

Large echelon spectroscope: Prof. A. Schuster, F.R.S. This echelon spectroscope, constructed by Messrs. Adam Hilger, Ltd., consists of 33 plates, and has a resolving power equal to that of an ordinary grating of 329,000 lines in the first order.—A hand refractometer: Mr. G. F. Herbert Smith. By means of this form of refractometer the refractive indices of any translucent substance, the refractive power of which lies within the effective range of the instrument, 1·400 to 1·760 approximately, may be determined with ease and celerity, to units in the second place of decimals if ordinary light, and to two or three units in the third place of decimals if the monochromatic light emitted by a volatilising sodium salt be the source of illumination.—The Ashe-Finlayson comparascope: Mr. D. Finlayson. This accessory to the microscope has been designed to enable the images of two different objects, separately mounted, to be projected side by side into the field of view, thereby enabling a thorough comparison to be made of their respective points of difference and resemblance. The apparatus consists of a prism placed above the primary objective which reflects to the ocular the rays from a secondary objective placed at right angles to the optic axis of the microscope.—(1) Torsion balance, used in radiation pressure measurements, by Nichols and Hull; (2) vacuum tube, of Nichols and Hull, to illustrate the repulsion of comet tails by the sun: Prof. E. F. Nichols.—An optical appliance to facilitate visual perception of ultra-microscopic particles: Mr. Carl Zeiss. The apparatus consists of a projection table provided with an arc lamp, optical bench, two projection aplanats, and a precision slit. (The use of sunlight instead of the arc lamp is preferable.) Particles of far less than half a wave-length can be made visible with this apparatus.—

Mechanical lantern slide illustrative of the phenomenon of a total solar eclipse: Mr. W. Shackleton. A white disc representing the sun is projected on a screen; by moving an opaque disc representing the moon, this is gradually obscured, and the preliminary partial phases of a total solar eclipse are shown. A moment before complete obscuration a twin shutter is opened, which allows the corona and chromosphere to be projected, thus reproducing totality, which may last as long as desired.—Stereoscopic views of the sun and stars of estimated parallax: Mr. T. E. Heath. The perspective drawings were made from a plan and elevations in which the scale of stellar distances was ten light-years to 1 inch, and of stellar discs such that the sun (or a star which gives equal light) was 1/50th of an inch in diameter. The magnitudes were made to vary with the varying distance of the spectator.—(1) Microscope and goniometer stage for examining the optical qualities of minute grains of sand; (2) set of petrological quartz wedges; (3) photomicrographic camera, designed by Mr. J. W. Gordon for taking small direct photomicrographs while the instrument is in use after observation without attention to the adjustments: Messrs. R. and J. Beck, Ltd.

(1) Photomicrographs of section of gun tube showing change in structure of steel after 2000 rounds; (2) photomicrographs of alloys of aluminium with nickel; (3) photomicrographs of alloy of copper with cobalt and nickel: Dr. Hodgkinson, Captain Playfair, R.A., and Mr. Coote. —(1) Apparatus for polishing and preparing metals for microscopic examination; (2) specimens of steels in the cast and forged condition containing phosphorus: Mr. J. E. Stead, F.R.S.—Transverse sections of slip-bands and other microscopic features of metallic surfaces: Mr. W. Rosenhain.—A series of alloys of iron and steel tested at liquid air temperature: Mr. R. A. Hadfield. The specimens showed the effect of liquid air (temperature $-182^{\circ}$ C.) upon almost pure iron (Swedish charcoal iron "S.C.I.," 0·04 carbon, 99·82 iron) and a large number of alloys of iron with other elements. The well known ductility of iron disappears, while its tenacity is more than doubled. Similar effects occur with nearly all the alloys of iron with carbon and other elements, except those containing nickel, which metal appears to modify considerably the embrittling effect of low temperatures upon iron.

Clock and chronometer by Thomas Mudge: Mr. A. Mallock, F.R.S. The clock was made about 1776, and contains Mudge's moon motion. Mudge's object in making this motion was to show that any desired velocity ratio could be approximated to very closely with comparatively few wheels. The train of wheel-work he employed makes the mean lunation 0·03 second less than the actual mean lunation, that is, the error is less than 1 in $2\frac{1}{2}$ millions. There are other remarkable features in this clock connected with the balance wheel, escapement, and temperature correction.—(1) Tangent-micrometer for theodolites, &c.; (2) endless-tangent screw for sextants: Mr. E. A. Reeves. By the addition of a micrometer "drum," and a simple arrangement for clamping the outer rim or dial carrying the numbers, combined with a special indicator, a carefully constructed tangent-screw serves also as a micrometer, and renders it possible to read the arc with the same accuracy as with the usual form of micrometer, while the instrument need not be larger than the ordinary vernier theodolite. The sextant device consists of a tangent-screw constructed with an endless thread, by means of which the vernier arm can be made to pass from any one part of the arc to another. For making rough contacts the tangent-screw is raised from the arc by means of a lever pressed by the finger. When the pressure on the lever is released the tangent-screw, actuated by a spring, again comes in contact with the arc, and serves as a clamp.

A direct reading cymometer for measuring the length of the waves used in wireless telegraphy: Prof. J. A. Fleming, F.R.S. The instrument consists of a sliding tubular condenser and an inductance coil, the capacity and inductance being varied together in the same proportion by one movement of a handle. The circuit is closed by a copper bar, which is placed alongside the aërial wire indicating the electric waves. The handle of the cymometer is then moved until a neon vacuum tube used as an indicator shines most brightly, and thus determines when the cymometer circuit is tuned to the frequency of the aërial. A pointer moving over a scale then indicates the wave-length of the radiated wave in feet or metres.—An oscillation valve for rectifying electrical oscillations and rendering them measurable on an ordinary galvanometer: Prof. J. A. Fleming, F.R.S. The valve consists of a bulb enclosing a carbon filament made like an incandescence lamp. The filament is surrounded by a metal cylinder. The bulb is highly exhausted. When the filament is incandescent, negative electricity can move through the vacuum from the hot filament to the cylinder, but not in the reverse direction. Hence the arrangement can separate out the two opposite currents in an electric oscillation. It can be used in combination with a dead beat galvanometer as a receiver in wireless telegraphy. The valve replaces the coherer and other appliances, and the signals are given by long and short deflections of the galvanometer.—(1) Resonance induction coil and high potential apparatus; (2) resonance electromagnet: Messrs. Isenthal and Co. Electrolytic condensers of very large capacity are charged from the mains through the primary of a suitably wound induction coil, and the circuit broken and reversed at zero potential by means of a motor-driven commutator of special construction. The advantages are:—no motor transformer is required in primary circuit, no rectifying device in secondary circuit, and there are no interruptors to be cleaned. The apparatus enables a current to be converted sparklessly into pure sine current suitable for space telegraphy. An electromagnet excited from a source of this kind exhibits peculiar physical and physiological phenomena.—(1) High-tension resonance transformer; (2) X-ray stereoscope: Mr. Russell Wright. The special form of "step-up" transformer exhibited works direct from the alternating current mains, and produces an alternating discharge of sufficient tension for X-ray work or high-frequency effluve. By means of a small revolving shutter, driven by a synchronous motor, between the observer's eye and two X-ray tubes, stereoscopic images could be clearly seen on an X-ray screen.

High temperature electric furnaces: Director of the National Physical Laboratory. These furnaces are constructed of rare earths such as are used in Nernst lamps. They are available for temperatures between 800° C. and 2000° C. The apparatus used in a recent determination of the melting point of platinum was shown at work, in addition to that for other experiments of a similar character.—New models of laboratory electric furnaces: Mr. R. S. Hutton. The furnaces consist of a carbon tube, rod, or plate heated by an electric current. In the tube furnaces the carbon is surrounded by some material of low thermal conductivity, which also serves to protect the hot tube from oxidation. The substance to be heated is placed in a carbon boat or crucible inside the tube, and can thus be brought to a very high temperature. The method employed for conveying the current to the carbon by soldering water-jacketed sleeves to the electro-coppered ends of the carbon forms a novel feature of the construction.

Photographs taken in China by the Carnegie expedition under Mr. Baily Willis in 1904, illustrating a presumably Glacial deposit underlying the base of the Cambrian rocks of the region: Sir Archibald Geikie, Sec.R.S.—Photographs, cast, and model of skull of Diplodocus, a Jurassic dinosaur from Wyoming, and other fossils from the middle west of North America: Dr. W. J. Holland.—Remains of fossil mammals from Crete: Miss D. M. A. Bate. Numerous mammalian remains were found in 1904 in the Pleistocene cave and fresh-water deposits of Crete. These include remains of the following animals:—antelope, deer, elephant, pigmy hippopotamus, shrew, and two species of rodents.—The great Indian earthquake, April 4: Prof. J. Milne, F.R.S. Five seismograms of this disturbance were shown from Shide, Isle of Wight. (1–2) Open diagrams on smoked paper showing north-south and east-west motion. (3) Open diagrams of east-west motion on photographic paper. The instrument was a Milne horizontal pendulum. (4–5) Photographic records from a pair of Milne horizontal pendulums vibrated north-south and east-west. The exhibit also included seismograms of east-west

motion from Edinburgh, Paisley, Beirut, and Toronto.—Charts of the Gulf of St. Lawrence, showing the co-tidal lines at mean time of Quebec: Captain Tizard, C.B., F.R.S.—Photographs of the "Cullinan" diamond: Sir William Crookes, F.R.S.

Microscopic preparations illustrating the development of calcareous spicules in various invertebrate animals: Prof. E. A. Minchin and Mr. W. Woodland. Calcareous spicules are small skeletal elements to be found in most of the lower animals. These spicules assume varied and often beautiful forms, those of sponges and "sea cucumbers" (Cucumariidæ and Synaptidæ) being especially striking in this latter respect, and are built up in all instances by the agency of scleroblasts—small nucleated protoplasmic masses which deposit the lime. The causes underlying the production of the curious forms which these spicules assume (triradiates, perforated plates, wheels and anchors, &c.) are not by any means yet understood, but are probably several in number, some being purely mechanical in nature, others, perhaps, being those which give rise to crystals.—Cellular constituents peculiar to cancerous and reproductive tissues: Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore, and Mr. C. E. Walker. In the cells of malignant tumours, structures known as "Plimmer's bodies" are present in most cases. These structures have been regarded as parasitic organisms or as specific cellular peculiarities confined to such malignant tissues. They have recently been identified as also being present in normal reproductive tissues. They form a definite organ of the cell during its conversion to a spermatozoon, and they also can be identified in the two preceding divisions. They are absent from other cells of the body.—The simplest kind of protoplasm: Dr. Charlton Bastian, F.R.S. One drop of a fluid swarming with common bacteria had been introduced into one ounce of distilled water containing ten grains of neutral ammonic tartrate in solution. The bacteria grow freely in this fluid, and as the constitution of the ammonia salt is $2NH_4O, C_8H_4O_{10}+2HO$, they must fashion their protoplasm in some way from C, H, O, and N only, though sulphur and phosphorus, one or both, are commonly regarded as necessary constituents of living matter.

The parasite of "kala azar": Brevet Lieut.-Colonel W. B. Leishman. This protozoal organism is found in the spleen and other organs in cases of "kala azar," an extremely fatal disease occurring in epidemic form in Assam, and also, in endemic form, in other parts of India and the tropics. Nothing is yet known as to the mode of infection or as to the life of the parasite outside its human host. In artificial cultures it develops into a flagellated organism closely resembling a trypanosome. Specimens and sketches were shown of the parasites as they occur in the tissues, and of the flagellated forms into which they develop in artificial cultures.—The isolation of *B. typhosus* from water by means of alum precipitation: Mr. H. S. Willson. Alum is added to the infected water in the proportion of 0·5 gram to the litre. When the precipitate of aluminium hydrate has fully formed, the water is centrifugalised and the sediment containing most of the bacteria present in the water is spread on plates of suitable media, and incubated at 42° C. The precipitate, which is known to be destructive to many water and sewage organisms, has no germicidal action on *B. typhosus*.

(1) Stone adze heads in various stages of manufacture, and chips from the neighbourhood of Suloga, Woodlark Island, British New Guinea; (2) photographs of straight-haired individuals from Nara district central division, British New Guinea; (3) wood carvings and drawings, principally from Massim district, British New Guinea: Mr. C. G. Seligmann. Specimens of cross-bred maize illustrating inheritance in accordance with Mendel's law: Mr. R. H. Lock.—Living representatives of the Plymouth marine fauna: Marine Biological Association. Material obtained with the dredge from certain typical grounds in the neighbourhood of Plymouth was shown, together with representatives of the animals living on each ground.—Photographs illustrating young cuckoo in the act of ejecting egg and young bird from nest of foster-parent: Mr. W. Percival Westell.

A new problem on superposition: Mr. H. E. Dudeney. This was a demonstration that an equilateral triangle can be cut into four pieces that may be re-assembled to form a square, with some examples of a general method for transforming all rectilinear triangles into squares by dissection.

Oil painting, a Friday evening lecture at the Royal Institution: Mr. H. J. Brooks.

## ATMOSPHERIC ELECTRICITY OBSERVED FROM BALLOONS.

It is now some years since attempts were first made to investigate the electrical conditions of the upper atmosphere by aid of manned balloons; but it is only within the last three years that the difficulties of the observations and the proper methods to be used have been anything like understood.

Measurements of the normal potential gradient were first attempted. The early observers worked very much in the dark, Linke being the first, in 1901, to investigate the errors due to the mere presence of the balloon itself. He found that for the influence of an uncharged balloon to be small enough to be neglected, the upper of the two collectors used must be at least 10 metres below the basket.

Linke also investigated the efficiency of different forms of collectors. The original form of collector used in balloon work was a modification of Kelvin's drop collector. A wire was lowered from an insulated vessel out of which water flowed and ran down the wire; the drops forming on the end of the wire and then falling off brought the whole wire to the potential of the air at its end. There are many objections to this form of collector; it is very slow in action, uses a large quantity of water, and will not work when the temperature falls below freezing. Flame collectors are obviously out of the question for balloon work on account of their danger, and, much to the regret of the experimenters, radium did not come up to expectation. The difficulty with radium collectors is that the radium ionises a large volume of air, which, on account of the absence of relative motion between the balloon and the surrounding air, travels along with the balloon and completely alters the electrical conditions of the atmosphere in its neighbourhood. By a simple device Linke has finally overcome all difficulties connected with the collectors. A vessel containing spirits is insulated on a shelf fastened to the outside of the basket. From this vessel hangs a long thin lead or other flexible pipe. At the lower end of the pipe is a nozzle which forms the collector proper. As stated above, the collector must be 10 metres below the balloon; thus there is at least a 10-metre head of liquid acting at the nozzle. The pressure due to this causes a very fine jet to escape from a pin-hole in the nozzle. As the jet breaks up into exceedingly fine drops, a very rapid collector action takes place. Collectors of this form have acted splendidly, and their use makes it possible to measure the potential gradient with accuracy and ease.

The rate of dissipation of electricity from a charged body, and the degree of ionisation of the air, have also been made subjects for investigation in the upper atmosphere. Ebert and Linke have devoted several ascents to measurements of the dissipation, and Ebert designed the first instrument to measure the natural ionisation of the air; but the ionisation has been most carefully investigated by Gerdien, who improved Ebert's instrument so that it measures not only the ionisation, but the conductivity of the air also.

It was when making these latter investigations that a number of difficulties connected with the casting of ballast were first observed. Ebert found that the pouring of sand from the ballast bags so highly charged the balloon with friction electricity that electrical observations became impossible. Gerdien found that after sand had been cast the balloon remained for some minutes in an atmosphere filled with fine sand dust, which greatly affected the measurements of the ionisation. Linke also found that on account of the sudden upward acceleration given to the balloon after sand had been cast the position of the electroscope leaves changed without any change of voltage. Gerdien was the first to overcome these difficulties. Besides sand, he took two large watertight sacks filled